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J. Phys.: Condens. Matter 1 (1989) SB179–SB180. Printed in the UK

Thermal and ion-beam-induced etching of InP with chlorine

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Received 23 March 1989

Abstract. Surface spectroscopic techniques have been used to investigate adsorption and thermal and ion-induced processes at the InP(100)–Cl_2 interface. Two adsorption states are identified and etching reactions are interpreted in terms of surface chemical transformations and desorption processes involving these states.

1. Adsorption and thermal desorption

Chlorine was exposed at 300 K to a (4×2) reconstructed InP(100) surface and Auger and thermal desorption spectroscopies used to investigate the adsorption. The uptake characteristics from the Auger data were of the type observed for many halogen chemisorption systems [1], showing initial rapid uptake, attributed to adsorption into a halogen overlayer, followed by much slower uptake into a multilayer corrosion phase. Analysis of the P : In Auger signal ratio as a function of Cl coverage indicated P depletion in the corrosion phase.

Thermal desorption spectra for varying chlorine exposures and desorbing masses are illustrated in figure 1. Two states are observed: a strongly bound state (labelled β), with uptake characteristics that correspond to the submonolayer state, and a weakly bound state (labelled α), corresponding to the corrosion phase. Cracking pattern analysis indicated that the α-state desorbs as $InCl_3$, while the β-state products are P_4 and InCl.

2. The ion-beam-induced process

In order to increase the rate of etching at low temperatures ion beam irradiation of the adsorbed phases was investigated. Following a 500 L chlorine exposure the surface was irradiated for various intervals with a 500 eV Ar^+-ion beam and the surface analysed by TDS. The results showed initially the rapid loss of the α-state $InCl_3$ desorption peak but with *negligible* change in chlorine coverage. Simultaneously the InCl and P_4 desorption peaks increased in size. The initial effect of the ion beam therefore appears to be to induce the transformation

$$InCl_3 + InP \rightarrow InCl + P_4$$

Subsequent irradiation results in the desorption of these products. Etching therefore

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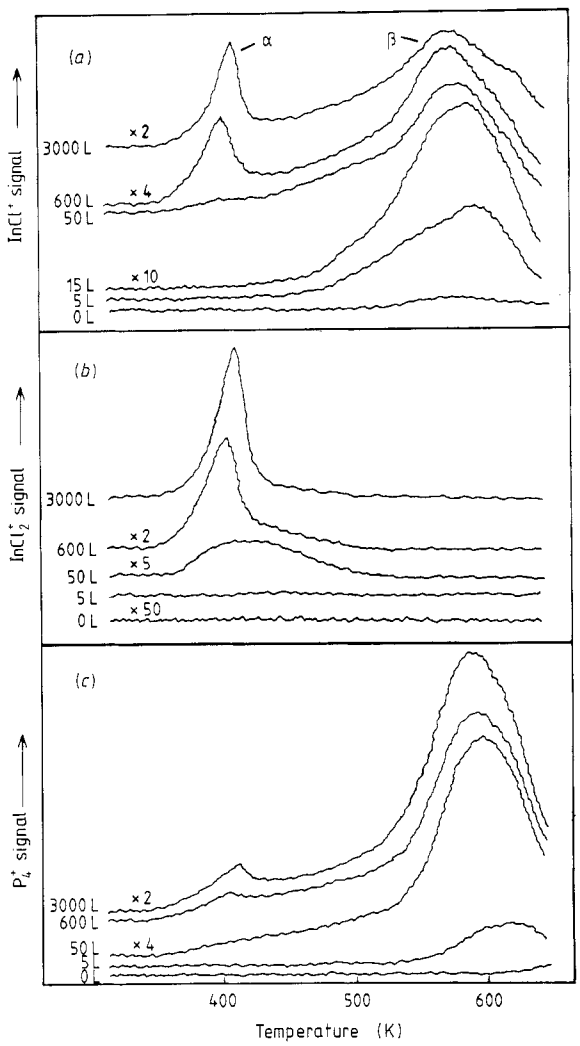

Figure 1. Thermal desorption spectra for (*a*) InCl, (*b*) $InCl_2$ and (*c*) P_4 plotted as a fraction of Cl_2 exposure (given by curves).

appears in this case to be a two-ion process. This is inconsistent with the thermal pulse model proposed in [2] and may be better described by a two-step collisional cascade mechanism [3].

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